Behavior of Persistent Bioaccumulative Toxicants in Fish Early Life Stages

Michael W. Hornung
Toxicologist, NHEERL Post-doctoral Fellow
ORD/NHEERL/MED
(218) 529-5236
hornung.michael@epa.gov

Key Words: aquatic stressors, mechanistic linkages, persistent bioaccumulative toxicants, fish early life stages

Whether through environmental criteria or site-specific risk assessments, many EPA programs rely on linking environmental exposures to levels of adverse effect (or no effect) in fish and wildlife. While empirical relationships of exposure to effect can be used for such assessments, understanding the processes and mechanisms of chemical uptake, distribution, and toxic effect in sensitive organisms and life stages is key to establishing effective benchmarks for ecological effect. Early developmental stages of vertebrates are highly sensitive to the toxic effects of many chemicals, and fish early life stages are especially sensitive to persistent bioaccumulative toxicants (PBTs). Assessing the risk posed by PBTs in aquatic systems is dependent upon an understanding of the potential of these chemicals to bioaccumulate and be metabolized. Only limited data exist in this area for fish early life stages. To understand the toxicity of chemicals during fish early development, it is important to determine in which tissues a given chemical partitions and whether it is stored, eliminated, detoxified, or metabolized to a more toxic form. Methods exist to follow the distribution of chemical contaminants in tissues and organs in adult fish; however, the small size of the embyro and larvae limits the analytical tools available to do this on a tissue-specific basis in organisms during these life stages. Recent advances in bioimaging technology provide a means to study the dynamics of the distribution of fluorescent chemicals in living biological tissue. The use of multiphoton laser scanning microscopy can be used to take advantage of the fluorescent properties of various environmental contaminants to image their distribution in fish embryos and larvae and follow changes in this distribution over time. Changes in the fluorescent intensity within tissues can indicate whether the chemicals are increasing, decreasing, or are metabolized within a tissue. The approach used in this project is to link bioimaging technology with analytical chemistry to determine where chemicals partition in early embryonic stages and compare how PBTs with different chemical and functional characteristics are processed by these early life-stage fish. The results of these studies indicate the importance of metabolism as well as octanol-water partitioning factors for understanding bioaccumulation in fish early life stages. By having a greater knowledge of the fate and distribution of chemicals in tissues, along with toxicity information, the USEPA can set standards for exposure for PBTs in the aquatic environment based upon strong scientific evidence linking exposure with a biological effect.